

Advanced Lane Line Detection

This project deals with determining lane lines by a series of procedures as follows:

- Camera Calibration
- Undistort the image
- Colour and Gradient Threshold
- Perspective Transform
- Identify lane lines by Histogram Peaks
- Measure the radius of Curvature and Fit the polynomial for Straight and Curvy Lanes.

Section 1: Camera Calibration

- Images are shown below which are present in the calibration directory.
- Camera Calibration function returns Camera Matrix and Distortion coefficients.
- 9,6 configuration is used to find the checkboard corners.
- cv2.calibrateCamera function is used to find out camera matrix and distortion coefficients.

Section 2: Undistorting the image

- Undistort function uses the camera matrix and distortion coefficients to undistort the image.

Section 3: Gradient Threshold

- The Sobel operator is the heart of Canny Edge Detection and it can be applied in two directions.
- orient is used as x because it emphasizes edges closer to vertical which we are interested in.
- The image has to be converted to gray scale and threshold values are set.
- Gradient threshold is calculated in the function abs_sobel_threshold.
- Magnitude of the gradient is calculated by square root of sum of squares.
- Threshold to the overall magnitude of the gradient in both x and y is applied.
- Direction of the Gradient is calculated as we are interested in edges of particular orientation.
- Direction of the gradient is calculated by inverse tangent of y gradient divided by x gradient. This is performed by arctan function.
- Combining thresholding is done by apply_threshold function which would take magnitude, direction and sobel gradient measurements of x and y to focus on pixels which might be a part of lane lines.

Colour Channels:

- For example, I have shown images with 2 colour channels.
- I consider 2 colour channels RGB and HSV.
- R channel in RGB is considered important because it does good job of highlighting lane lines.
- S channel in HSV is considered because it is more robust to lane lines of different colour and handles shadow conditions on the road.
- Next there is a combination of threshold between gradient and S channel threshold.
- b channel is not considered in rg_threshold function because it is not recognised in the gray image.
- grad_thresh function performs the overall gradient and color threshold for the pipeline considering light and saturation level color channels with x sobel operator thresholds.
- Their magnitude and direction is both considered to get clear emphasis on the lane marking.

Section 4: Perspective Transform

- This section performs Perspective Transform by warping the image.
- We are interested in creating the bird's eye view of all lane images.
- Source and destination points are marked. They are used to calculate both perspective Transform and Inverse Perspective Transform.
- Different values of hue,saturation and value are selected to emphasize both yellow and white lanes.

Section 5: Identify Peaks in the Histogram

- Test the bottom of the image to find the peaks of the histogram.
- This is a possibility of giving the lanes information.
- That peaks give the x positions in the image and then keeping that as the reference, using sliding window approach, we go the top of the picture to find all the relevant peaks of the histograms to find the lanes.

Section 6: Fit the polynomial and find the radius of curvature

- x and y positions are taken from the previous function and they are fit with a second degree polynomial function.
- The calculated radius of curvature has to be calculated on to the real world space.
- The lane width can be considered as per standard pixel space per metres and radius of curvature is calculated accordingly for real space.
- The whole pipeline is implemented in Line Class and video is also embedded.

Discussion:

- The problems faced with respect to pipeline were regarding trying different colour channels.
- Since I studied Object Tracking Module, I made use of HSV colour channel instead of proposed HLS in the classroom session.
- Shadow correction can be improved in the pipeline because the video shakes during shadows.
- Hypothetical situations might be that when there is no left lane marked in the road and only right lane is marked, pipeline might fail.
- I guess this pipeline can work only in highway roads.